"For the public benefit"? Railways in the British Cape Colony[1]

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Abstract

Built largely to support the early mining industry, the Cape Colony's railway substantially reduced the cost of transport to the interior and account for 22 to 25 percent of the increase in the Colony's labor productivity from 1873 to 1905. Little of the gains went to the state-owned company: the Cape government seems instead to have mainly considered the railway as a means to local development. In this regard, traffic data for 1905 suggest that the railway contributed to the expansion of the mining areas and to the growth of the Western Cape district on the basis of domestic demand.

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1. Introduction

> Roads and railroads were for the public benefit, and in their construction they should not look forward to profit. (MP Robert Godlonton in the Cape Legislative Council, 1870)[4]

In the decades preceding World War One, the ability of many economies in the periphery to take advantage of the opportunities opened up by globalization largely depended on the availability of good inland transportation facilities. In a large number of peripheral countries, due to the widespread shortage of alternative infrastructure and the scarcity of navigable routes, the railway became essential as the cheapest available means for the inland conveyance of freight (see e.g. Findlay and O'Rourke, 2007, pp. 382, 405). Although the railway did not generate growth in the absence of other essential development factors, its absence could significantly constrain economic expansion, limiting the potential growth effects of globalization to those areas closer to the coast or navigable rivers. Across the periphery, economic activity often followed the railway tracks, which shaped the economic geography of many countries even long after railways had ceased to operate.

In this paper we make a preliminary approach to the effects of the Cape Colony railways during the late nineteenth and early twentieth century globalization period. This railway system was among the largest and densest in sub-Saharan Africa. Although the Cape accounted for less than 2 percent of the total surface area of the region, by 1910 22 percent of the sub-Saharan African railway mileage had been built in the Colony (Mitchell 2003a). In addition, the rail transport sector share of the Cape GDP was amongst the highest in the world before 1910. Across the developing world, the railway boosted growth primarily by reducing transport costs. The size of the reduction depended on two factors: the cost advantage over the next best alternative, and the amount of freight and number of passengers transported. The Cape railway was not notable for the former (compared with other African countries, where the main alternative was head porterage), but the high volume of Cape rail traffic (relative to GDP) had large resource saving effects.

The boom in mining production weighted the Colony's economy heavily towards rail transport. Its railways were mainly built to connect the ports and farming districts first with the Kimberley diamond fields and then with the Witwatersrand goldfields in neighboring Transvaal. By

[4] *Debates*, Vol. III (1870), p. 241.

reducing the cost of transport to the interior, the railway eased the movement of labor, capital goods, foodstuffs and other necessities to the mining centers. This transformed the Cape from a traditional agrarian society into a dynamic economy attractive to immigrants. Diamond production became easier and the Kimberley district flourished, as did providers of basic items. Estimates show that the Cape's GDP grew at a yearly rate of 4.77 percent between 1870 and 1909 (Greyling and Verhoef 2015). In helping to remove restrictions to the expansion of mining production, the railways contributed to the development of some of Africa's biggest industrial hubs.

With the exception of a few private lines, the Cape railways were built and managed by the colonial government. In contrast with their sizeable social benefits, the railway company was not a significant source of net public revenues. Debates in the Cape Legislative Council show that the railway was seen neither as a source of direct revenue nor as a political or military tool, but as an instrument for the economic development of the different areas of the Colony. In this regard, the railway would have been instrumental not only to the expansion of the mining districts but also to the growth of the Western Cape region, whose production could expand thanks to market integration and the pull of domestic demand.

Our paper contributes to three bodies of research. The first is the literature on the economic growth and development of the Cape Colony during the first era of globalization (Greyling and Verhoef 2015; Cilliers and Fourie 2016; Cilliers and Mariotti 2016; Fourie et al. 2016). Boshoff and Fourie (2016), in the first quantitative study of how improvements in transport boosted the Colony's economy, examine South African market integration into the global economy and estimate 1872 as the date when the region's wheat markets were integrated with those of Britain's. The railway, they argue, clearly played an important role, but they are unable to quantify the size of its impact. This paper is the first to provide a quantitative assessment of the contribution of railways to the economic expansion of the Cape during the first globalization.

The second is the literature on the effects of railway construction on the economies of developing countries during the first globalization. Many of these studies are based on the social saving methodology (Coatsworth 1979; Ramírez 2001; Summerhill 2005; Herranz-Loncán 2011, 2014; Chaves *et al*. 2013; Zegarra 2013; Bogart *et al*. 2015). Others use detailed archival data to provide a microeconomic perspective on railway growth effects in various countries worldwide (e.g. Tang 2014; Donaldson 2016; Jedwab *et al*. 2016; Jedwab and Moradi 2016). We adopt the first approach and measure the broad resource saving effects of the railway in the Cape Colony, comparing them with estimates for other developing countries. We leave for

future research the systematic analysis of the local and regional economic effects of the Cape railway.

The third is the literature on the political economy of infrastructure provision and management (Summerhill 1998; Bogart and Chaudhary 2015). While railways in many periphery countries were built by foreign private capital (see e.g. Bignon *et al*. 2015), the Cape is an interesting example of a large network owned and managed by the government. Bogart (2010) shows that increasing state ownership reduced efficiency in most countries, with varying effects according to whether the increase was through nationalizations or new construction. Bogart and Chaudhary (2012), however, show that the move toward state ownership of India's large public railway system decreased operating costs and helped make the railways a source of public revenue. This, they argue, was as a result of an undemocratic colonial government, a fiscal system heavily reliant on railway revenues, and a regulatory environment that was not conducive to private competition. The situation was different in Australia, where concerns for profitability were soon replaced by general social and economic considerations in railway policy (Boot 1996). Similarly, the colonial Cape government expanded the network from the start without never considering it as a potential source of direct revenue. Railway expansion was instead explicitly aimed at encouraging the development of the different regions of the Colony, probably benefitting those groups, such as mine owners and Western Cape farmers, whose interests were best represented in parliament. Investment would only be recouped indirectly through economic expansion and the resulting increase in custom revenues. The contrast between colonial India and the Australian or Cape Colony cases illustrates the different effects of railway public ownership under very different social and political circumstances.

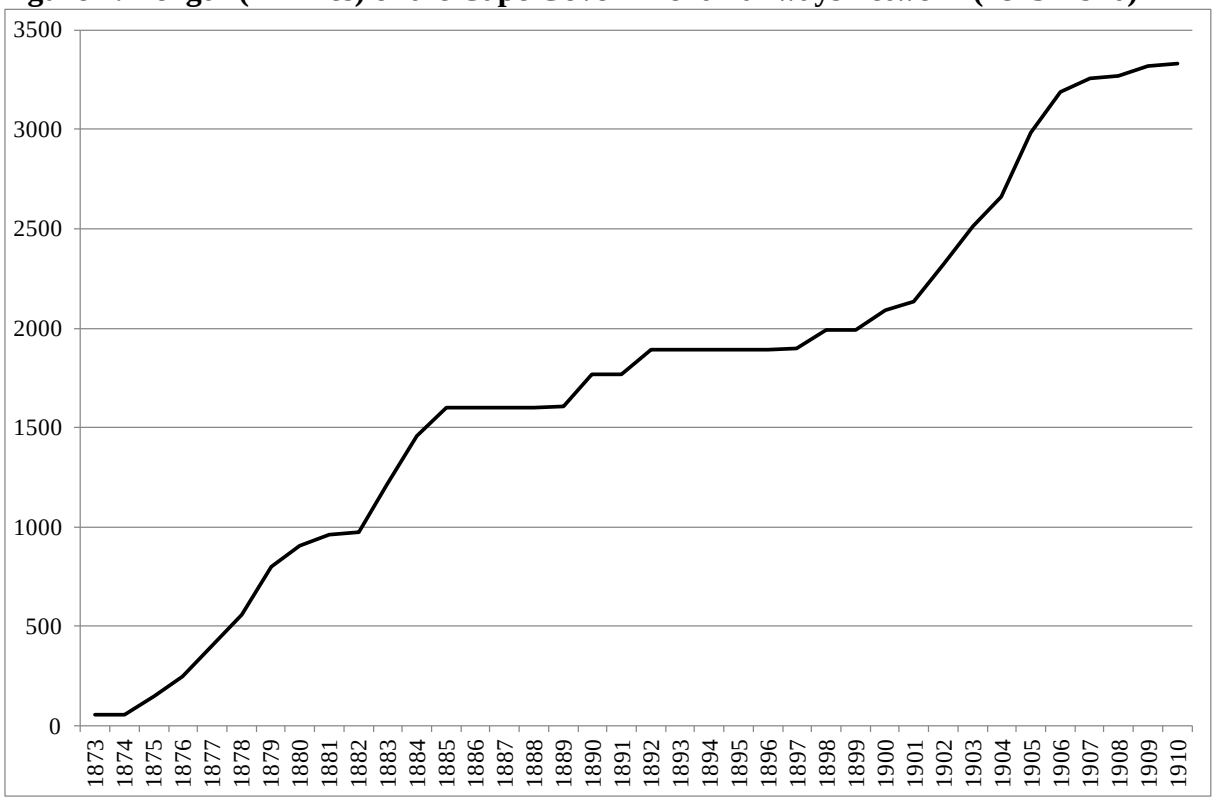
2. The development of Cape railways

Construction on the first railway at the Cape started in 1859 but progress was slow until the early 1870s.[5] At that date the only stretch in operation was a 57-mile line between Cape Town, Wynberg and Wellington. The government acquired it in 1872, only a few years after the

[5] Data used in this research come from several sources: the *Debates in the Legislative Council (1870–1895)*; the *Report of the General Manager of Railways (1906–1909)*; the *Statistical Register of the Colony of the Cape of Good Hope (1900–1910)*; the *Reports of the Blue-Books for the Cape of Good Hope* (1883-1901); the *1890 Agricultural Journal of the Department of Agriculture of the Cape Colony*; the *Union of South Africa's Official Year-Book of the Union, No. 2, 1918*, published in 1919; and the *Census of the British Empire, 1901, Report with Summary and Detailed Tables for the Several Colonies…, 1906* (see Supplementary material for full details). These documents are referred to in the paper as the *Debates*, the *Report of the General Manager*, the *Statistical Register*, the *Blue-Books*, the *Official Year-Book*, the *Agricultural Journal* and the *Census*.

discovery of diamonds at Kimberley (1866), and from then on the construction and operation of the network remained a public undertaking by the Cape Government Railways (CGR).[6] With the diamond rush and later the discovery of gold on the Witwatersrand in 1886, construction accelerated rapidly. The Cape Colony's rail network initially consisted of three trunk lines connecting the ports of Cape Town, East London and Port Elizabeth with the diamond producing area around Kimberley. It was gradually enlarged with numerous branch lines and, by 1910, when the CGR was incorporated into the Union Government Railways, it had reached a length of more than 3,300 miles. Together with the railways of the Transvaal and the Orange River Colony, it was by far the largest and densest network in Africa, both per square mile of surface area and per capita, and one of the largest outside Europe and the US. Figure 1 shows how it grew and table 1 compares the size it had reached by 1912 with the size of other countries' networks.

Figure 1: Length (in miles) of the Cape Government Railways network (1873–1910)



Source: Official Year-Book.

[6] The only exceptions were a private, narrow-gauge, mining railway between the Namaqualand copper mines in the O'Okiep area and the sea, which was built in the 1860s as a horse-drawn railway, gradually adapted to steam, and closed in 1945, and the 205-mile line between Worcester and Mossel Bay, completed in 1906 and managed by the New Cape Central Railway company until its takeover by the South African Railways in 1925.

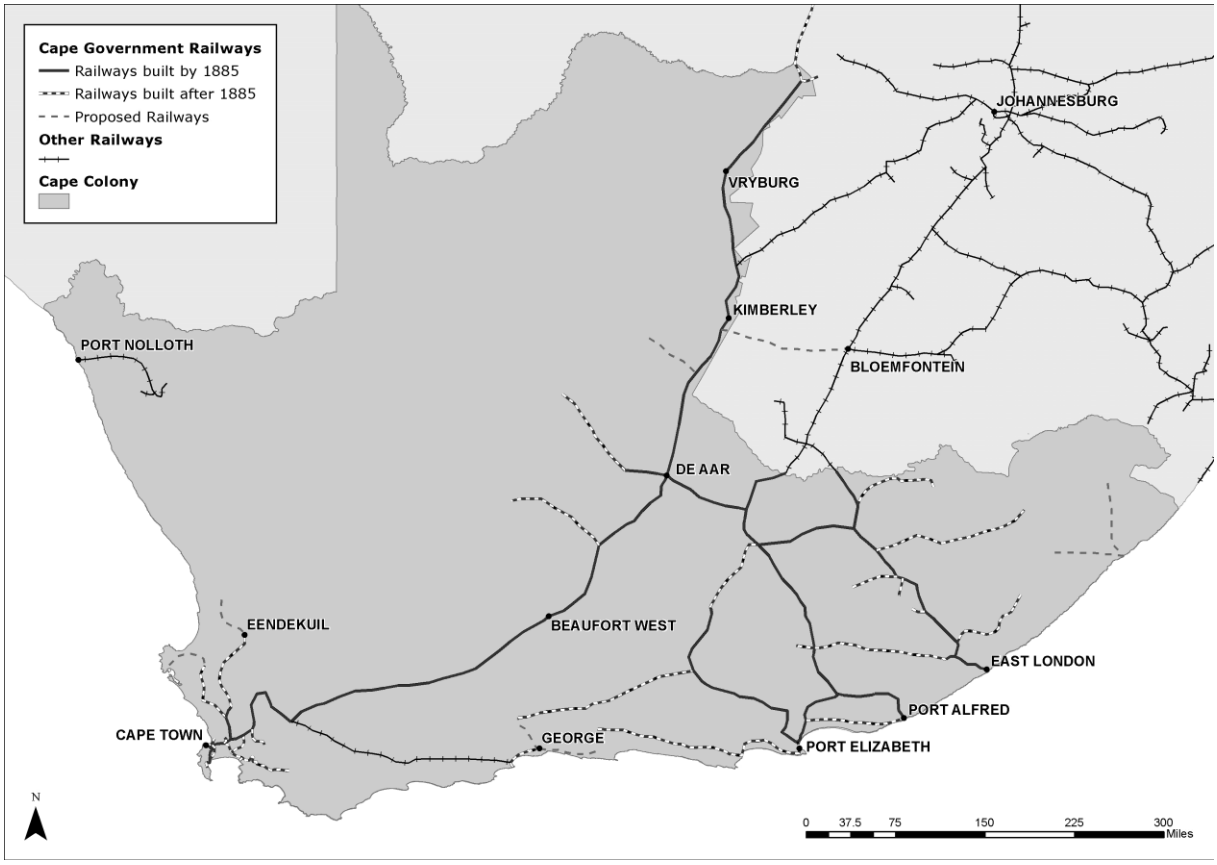
Table 1: Cape's Railways in 1912 compared with other countries

	Railway km	Km per 10,000 sq kms of surface	Kms per 1,000 pop.
Cape (1912)	5,621	78.48	2.19
South Africa (1912)	12,552	102.70	2.10
Nigeria (1911)	438	4.74	0.02
Gold Coast (1911)	270	11.33	0.14
Argentina (1912)	29,454	111.24	4.27
Mexico (1912)	24,963	103.74	1.27
Brazil (1912)	23,857	27.60	0.94
India (1912)	53,919	217.48	0.18
Japan (1912)	11,384	480.92	0.22
US (1912)	397,387	681.90	2.67

Sources: For the Cape Colony and South Africa, *Official Year-Book*. For other countries, Mitchell (2003a,b).

Figure 1 shows two main periods of intense railway building in the Cape Colony before 1910, largely related to the desire to connect the Cape ports with the diamond and gold mining fields, respectively. In the first one, between 1875 and 1885, the government reached the initial objective of the network, which was to connect the three main ports of the Colony (Cape Town, Port Elizabeth and East London) with the diamond-producing area of Kimberley. Construction largely stagnated thereafter, until it took off again from the end of the second Anglo-Boer War, when British rule was established in Transvaal. In this second expansion, investment was concentrated on linking the Cape Colony with the Witwaterstrand gold fields, in Transvaal, by two alternative routes: a direct one through Orange, and an indirect one that ran beyond Kimberley and along the border of the Cape Colony. In addition, the government also built during this second stage a large number of branch lines that would act as feeders to the trunk lines or as connections between them. Figure 2 shows the CGR network in 1907. The construction of branch lines continued through the late 1920s, bringing the total network length to over 5,000 miles.

Figure 2: Map of Cape Colony rail network in 1907

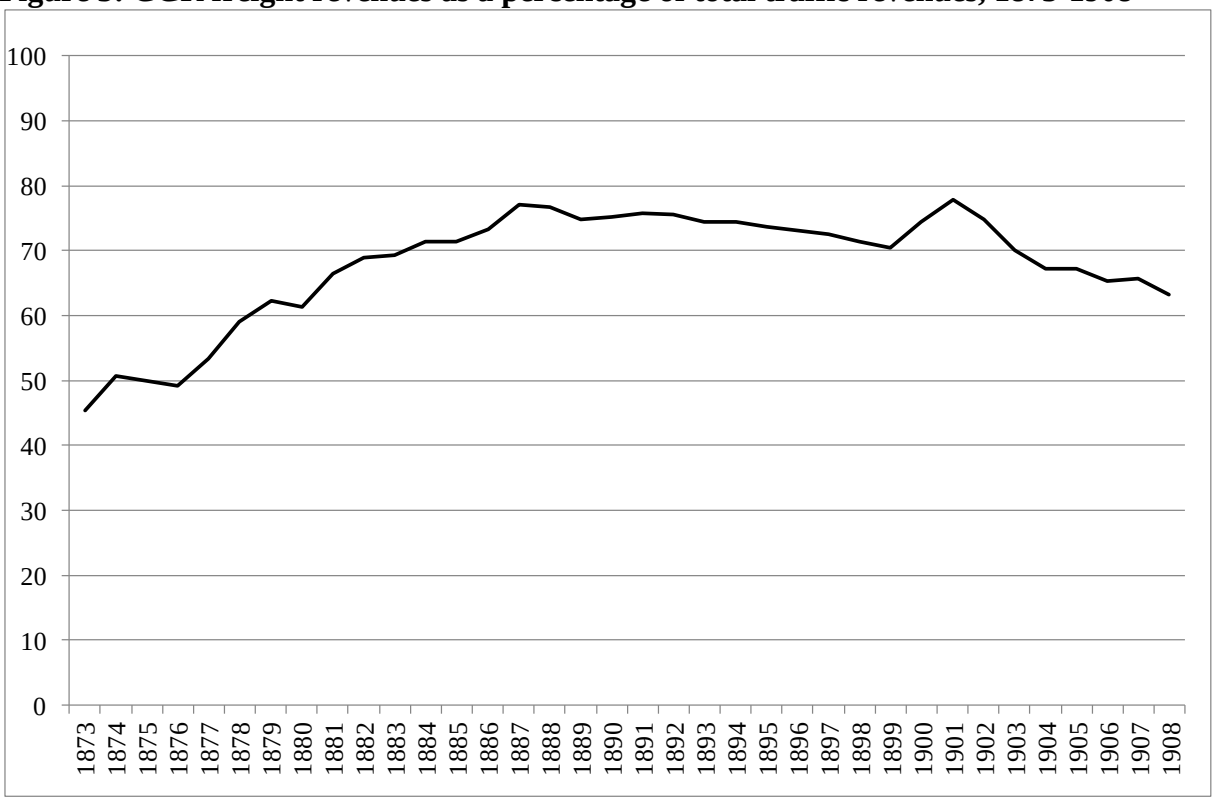


Source: own elaboration on the basis of the *Report of the General Manager for 1908.*

Like railways in other resource exporting countries, those of the Cape Colony were used mainly to carry freight, although passenger traffic was also sizeable, amounting for almost one-third of total revenues (figure 3). The *Report of the General Manager* for 1908 provides data on the composition of freight revenues between 1903 and 1908 (Table 2). The biggest category by far was "general products" (36 percent of total revenues), which included all commodities not classified under other categories, i.e. essentially manufacturing goods.[7] The next headings in importance were agricultural goods (25 percent), and coal and coke (13 percent). None of these categories accounted for a significant share of the Cape Colony's exports, which largely consisted of minerals and animal products.[8] This means that the conveyance of the Colony's exports towards the ports represented just a small part of railway freight transport, which was instead dominated by the movement of imports and domestic produce towards the country's consumption areas.

[7] This category also included wines and spirits of foreign origin, but not those produced in South Africa.
[8] According to the Cape Colony trade statistics, for instance, "minerals, metals and precious stones" accounted on average for 76 percent of the value of the Colony's exports between 1894 and 1903, and an additional 23 percent consisted of products of the sheep, cattle and ostrich farming; see *Blue Books*.

Figure 3: CGR freight revenues as a percentage of total traffic revenues, 1873-1908



Source: Cape of Good Hope, *Report of the General Manager for 1908*.

Table 2: Composition of freight traffic of the Cape Government Railways (1903–1908) (% of total tons transported)

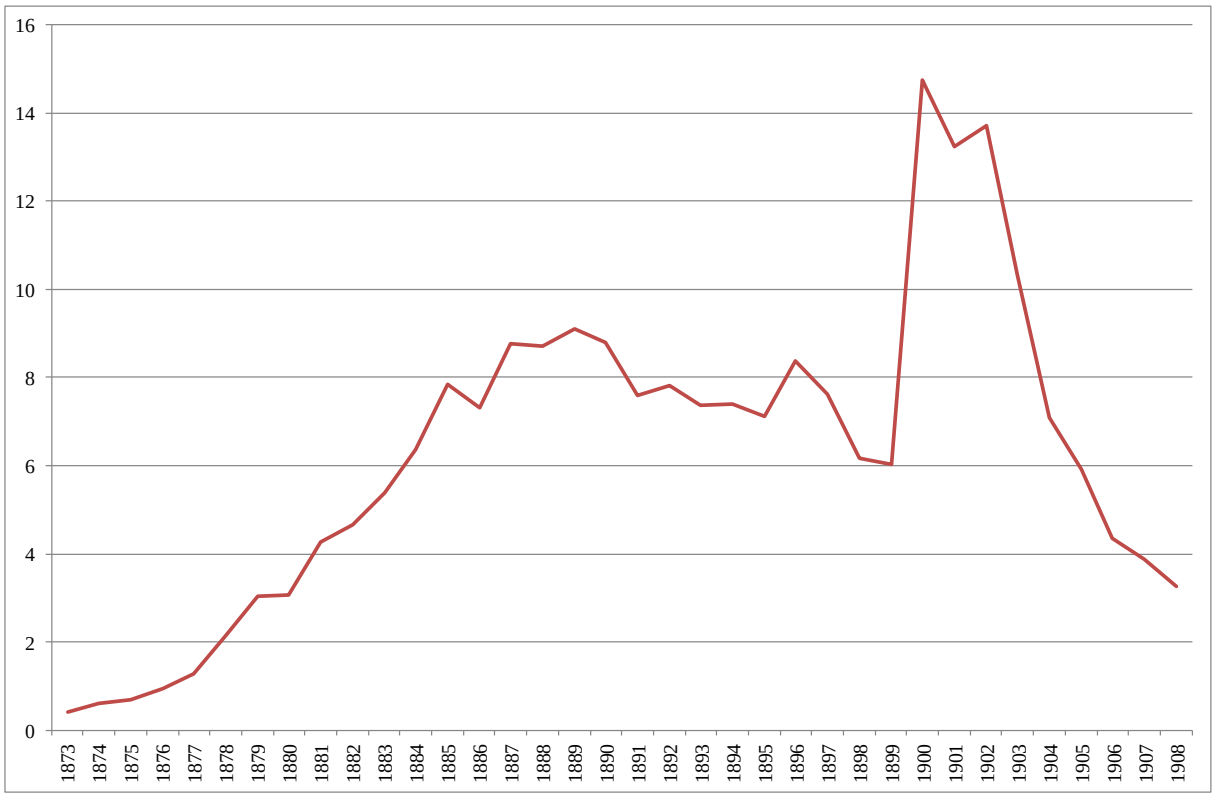
General products	36.10
Agricultural products	25.13
Coal and coke	12.53
Timber, firewood, bricks…	8.96
Animal products (wool, skins, hides…)	5.98
Minerals and gravels	5.29
Foreign railway material	4.56
Wines and spirits	1.45

Source: Cape of Good Hope, *Report of the General Manager of Railways for the year 1908*

From 1873 to 1908 the Colony's railway traffic kept pace with diamond production in the Kimberley area, decreasing only since 1905, when international competition caused a crisis in the diamond market. During the diamond boom, as figure 4 shows, and even leaving aside the

1900–1902 peak (associated with the extraordinary transport requirements of the second Anglo-Boer War), rail freight transport accounted for an exceptionally high share of the Cape GDP.[9]

Figure 4: CGR traffic revenues as a percentage of the Cape's GDP, 1873-1906



Source: Report of the General Manager of Railways for 1908, and GDP figures from Verhoef et al. (2014).

3. The social savings of the Cape Government Railways

In this section we estimate the direct benefits the Cape economy obtained from the railway through the calculation of social savings. These measure "how much extra society would have to pay to do what it did after an innovation, without it" (Leunig 2010, p. 776). If we assume that transport prices are equal to marginal costs, we can estimate social savings as:[10]

$$SS = (P_{ALT} - P_{RW}) \times Q_{RW} \qquad (1)$$

where P_{RW} is the average railway transport price and P_{ALT} is the average price of the next best alternative transport (under the counterfactual of no railways) in the year of reference, and Q_{RW} is that year's rail transport output.

[9] By contrast, the effect of the gold production boom is less evident in the figure, since the CGR had to compete with lines going to Portuguese East Africa and Natal for the Witwatersrand trade.

[10] This assumption is usual in social saving estimates when there is insufficient data to estimate marginal costs (Leunig 2010, p. 776).

Social savings, which were originally created by Fogel (1964) and Fishlow (1965), have a solid theoretical justification, since they give an upward-biased estimate (due to the implicit assumption of a price-inelastic transport demand) of the rise in consumer surplus provided by the railway. Additional consumer surplus remains the best definition of the welfare value of a new technology under competitive conditions (Leunig 2010). In the absence of perfect competition in the railway sector, the estimate should be increased by the potential supernormal profits of the railway companies (net of the opportunity cost of capital and amortization expenses) to obtain a complete measure of welfare gains. Thus, when social savings are corrected for the elasticity of demand and increased by railway companies' surplus, they represent a measure of the total direct income gains that an economy obtained from the railway technology. This measure should be equivalent to the rise in total factor productivity directly provided to the economy by the railway (Crafts 2004; Leunig 2010, p. 782). Crafts (2004) identifies several advantages of the social savings over direct estimates of TFP effects, such as its clear focus on benefits to users and gains from consumption (rather than production), and the fact that it does not require to measure output in the sector that uses the new technology, which may be very difficult in historical contexts.

The social saving method, however, has received some theoretical and empirical criticisms. On the theoretical side, social savings are downward biased estimates of TFP gains, because they exclude all indirect benefits the economy obtained from the railway through forward and backward linkages, such as increased productivity provided by the scale and agglomeration economies that the railway made possible, or certain industries' costs savings associated to railway input demand (Fogel 1979, p. 5). On the empirical side, their estimation often incorporates some oversimplified assumptions, especially on the characteristics of the counterfactual economy without railways or, more concretely, on the cost structure that the previous transport technology would have under significant rises in demand (Fogel 1979, p. 6; Leunig 2010, p. 786). In this context, social savings always requires sensitivity analyses, to give an idea of the potential error margin associated to the underlying assumptions.

Despite those criticisms, the social savings are still valuable as an overall measure of the direct gains of the railway and, moreover, they are based on evidence that is often available for past economies.[11] In addition, as stated by Fogel (1979, p. 6), one of the advantages of the social

[11] Recent research by Donaldson and Hornbeck (2016) has provided an alternative methodology to measure the aggregate growth effect of railways through the impact of local changes in market access on land values. The amount of evidence required to apply this approach, however, is not available for most world economies during the railway era.

saving methodology is that it brings together a great deal of relevant information on the transport sector, which can be used to draw relevant implications beyond the social saving estimate itself. For instance, the underlying evidence allows decomposing the social savings between different resource saving sources, such as increasing traffic volume and railway cost advantages over the alternative means. Moreover, this methodology allows comparing railway gains in different economies, which should be one of the main objectives of the social saving analysis (Leunig 2010, p. 799). The next subsections present social saving estimates for the Cape Colony railway freight and passenger transport in 1905, a year that we consider representative for the "normal" level of railway business in the colony. The necessary data to estimate social savings are only available for 1903-1908, and the choice of 1905 is justified because it was affected neither by the exceptional transport demand associated to the Second Boer War nor by the worst stage of the diamond crisis (see figure 4).[12]

3.1 Freight traffic

To estimate social savings we need to know, first, the amount of freight (ton-miles) transported by rail and the unit prices of rail transport in 1905. This information is available in the *Report of the General Manager* for that year.[13] Second, we need to estimate the price of counterfactual transport, i.e. the unit price of alternative means of transport had there been no railways. This is probably the most controversial aspect of the social saving calculation. As stated by Leunig (2010, p. 786), "assessing the cost structure for an obsolete technology facing significant rises in demand is not a straightforward counterfactual to develop, particularly if, like Fogel, you are trying to make an assessment in a period long after efforts to improve that previous technology have ended." Fogel (1979, p. 6) himself recognized the difficulty of the matter when he indicated that the social saving model did not include a specific or "right" definition of the counterfactual transport function. In fact, he actually developed three different versions of that function in his estimation for the US in 1890, allowing for different degrees of improvement of alternative transport means, compared with their actual condition in 1890 (such as additional non-existent canals or road surface investment). As a result he provided a whole "set of

[12] The ratio of railway freight revenues to GDP in 1905 (5.9 percent) was similar to the average of the whole period 1873-1908 (5.4 percent) (see sources in Figure 4). On the other hand, a preliminary calculation of the freight social savings for each year of the period 1903-1908 would yield an average estimate over those 6 years of 12 percent of GDP, practically identical to the individual estimate for 1905 (see below).

[13] Lack of data obliged us to exclude from the calculation the transport of livestock, vehicles and parcels at high speed, which accounted for approximately 12 percent of the total revenues of (low and high speed) freight transport between 1891 and 1908.

plausible alternative characterizations of the production function for transportation in the absence of railroads." However, due to scarcity of information and methodological difficulties, most of further social saving estimates have ignored the possibility of counterfactual improvements and use the actual situation of alternative transport in the year of analysis.

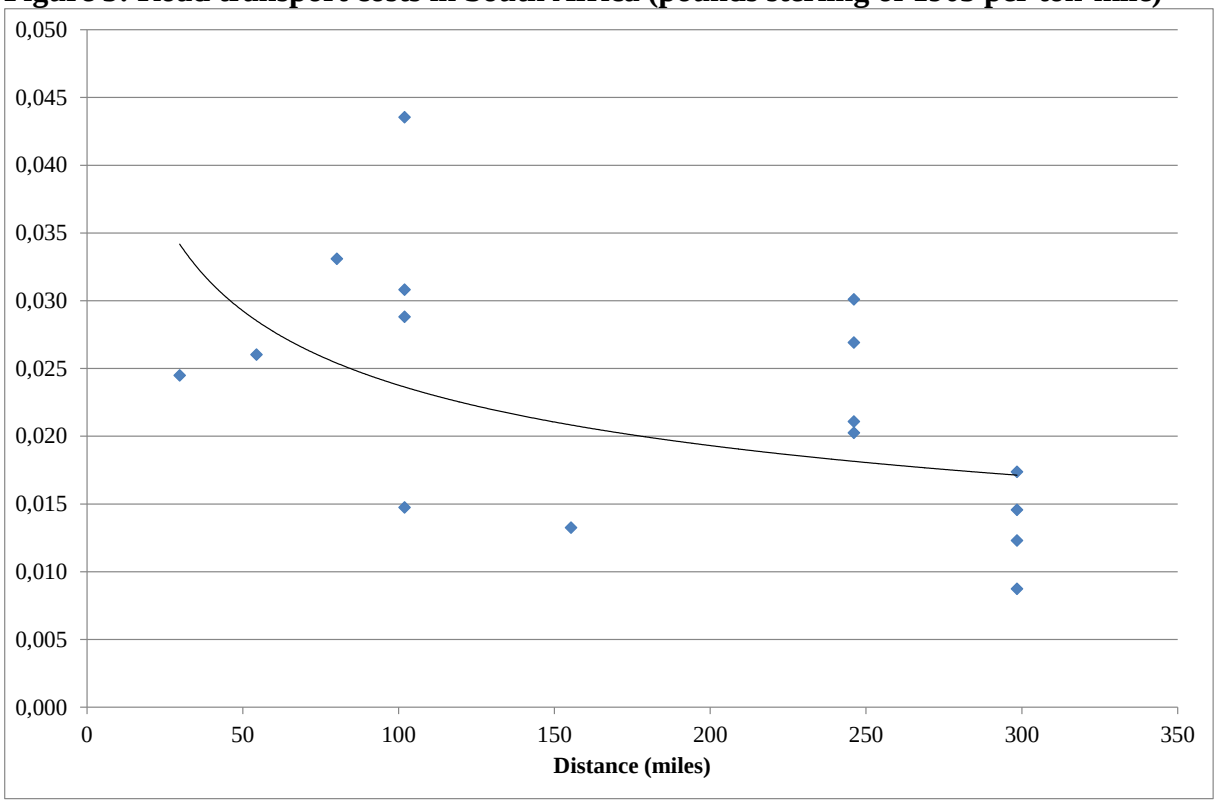
In the case of the Cape Colony, and given the absence of waterways, we assume that, in the absence of the railway, freight traffic would have been moved by road. We get road transport prices from two different sources of information. Firstly, we estimate the differences in 1890 between the prices of four agricultural products (barley, maize, oat hay, and wheat) in three South African cities that were not connected by rail in that year (Kimberley, Johannesburg and Bloemfontein).[14] Although differences between commodity prices do not allow for a very precise estimation of transport costs (see Buringh *et al*. 2016), they have already been used by other authors (e.g. Donaldson 2016; Temin 2013) and their level is consistent with evidence from other sources (see below). According to this information, in 1905 prices, average grain trade costs per ton-mile were 0.031 pounds sterling between Bloemfontein and Kimberley (about 100 miles), 0.026 pounds between Bloemfontein and Johannesburg (about 250 miles), and 0.014 pounds between Kimberley and Johannesburg (about 300 miles). Although the evidence is too sparse to confirm it, these figures suggest that road transport unit prices tended to decrease with distance. This is usual in transport cost functions (also in railways), due to the existence of certain costs that are independent from haul (such as loading and unloading costs, administrative costs, license fees, etc.).

Secondly, we have collected direct information on road transport prices from various sources. For instance, the *Report of the General Manager* for 1906, estimating the competition that ox-wagons still represented for the railway, reported a price of 29 pence for transporting 100 lb (pounds) of general goods from Port Elizabeth to Grahamstown, which would be equivalent to 0.033 pounds sterling of 1905 per ton-mile over a distance of 80 miles. Rhind (1995) and Pirie (1993) also supply some evidence of prices charged by ox-wagon carriers in various areas of the Cape. Transformed into pounds of 1905 per ton-mile, these data are equivalent to £0.024 between Robertson and Worcester (30 miles); £0.026 between Port Elizabeth and Humansdorp (54 miles); and £0.013 between East London and Elliot (155 miles). If we adjust all these observations to a log cost function of distance (figure 5), and apply the estimated function to the average distance travelled by rail freight in 1905 (197 miles), the resulting rate for ox-wagon

[14] Our agricultural price data come from several issues of the *Agricultural Journal*, which provides monthly prices; we use the average over the 12 months of the year 1890.

transport is £0.020 per ton-mile, i.e. triple the average rail freight cost of about £0.007.[15] Table 3 shows the social saving estimate (not adjusted to the elasticity of demand) that results from using this figure as representative of counterfactual transport rates, which amounts to 12 percent of the Colony's GDP in 1905.

Figure 5: Road transport costs in South Africa (pounds sterling of 1905 per ton-mile)



Sources: see text. Transport prices (or agricultural price differences) are expressed in pounds sterling of 1905 using Verhoef et al.'s (2014) CPI.

Table 3: (Unadjusted) social savings of Cape Colony rail freight (1905)

1. Railway economy	
a) Railway freight (million ton-miles)	361.03
b) Railway market price (£ per ton-mile)	0.0065
c) Railway freight revenues (million £) (a x b)	2.335
2. Counterfactual economy	
d) Carting transport freight (million ton-miles)	361.03
e) Carting transport price (£ per ton-mile)	0.0204
f) Carting transport cost (million £) (d x e)	7.378
Social savings (million £) (f –c)	*5.042*
As % of GDP	*12.01*

Sources: See text and, for nominal GDP, Verhoef et al. (2014).

[15] Alternatively, if we calculated the simple average of all available figures, or the direct evidence on prices (ignoring the information on agricultural price differences), the result would be only slightly higher (0.023 and 0.024 respectively).

There are several possible sources of bias in our estimate. To start with, most available evidence on carting rates refers to grain transport, whereas higher prices may have been charged for transporting other goods, such as industrial products. Secondly, the available prices might not be representative for a counterfactual economy with no railways, for several reasons. On the one hand, in the absence of railways, road transport prices might have been higher than their actual level, due to congestion of the system or less competition in the transport sector.[16] Alternatively, under no railway construction, the government's potential investment in road improvement might have helped to lower the rates charged by carriers. None of these effects is easy to quantify with the available evidence and it is not possible to know to what extent they cancelled each other. As an approximation to the potential impact on the social saving figures, we have calculated these using, as alternative road transport prices, the average of the 50% highest and lowest observations of the carting price sample. These results can be seen in the Appendix, and they provide information about the potential extreme scenarios and error margin of the social saving estimates. Despite the error margin being relatively high, something which is usual in social saving analysis, we keep our original estimate for the sake of comparability, as it is based on similar procedures to those applied in most social saving calculations available for other economies.

Table 4 compares our social saving figure with estimates for other countries and decomposes them among their two main determinants: the size of each country's railway sector and the difference between the prices of rail and alternative transport. The table shows that the freight social saving in the Colony was lower than in other primary exporting countries that also built dense rail networks during the first globalization, such as Mexico or Argentina, but higher than in other sub-Saharan African countries.[17] The Colony's advantage over the latter may be explained entirely by the very large size of its railway sector, since traditional road transport in the Cape was relatively competitive, compared not only with the cost of head porterage but also with the price of road transport in Latin American countries.

[16] An indirect evidence pointing in this direction is that road transport prices seem to have been much higher some decades earlier. In 1873 some were reported that would be equivalent to 0.048 to 0.062 pounds of 1905 per ton-mile on several long-distance routes from Port Elizabeth (*Debates* 1873, p. 72). See also Ross (1998, p. 335) on the transport of copper to the sea in Namaqualand.

[17] Jedwab and Moradi (2016), though, suggest that social savings might have been much higher (27 percent of GDP) in Ghana in 1931.

Table 4: Social savings of the Cape Colony rail freight (1905) compared with other countries

	Rail freight social savings as % of GDP	Rail freight revenue as % of GDP	Ratio of alternative to rail freight transport price
Cape Colony (1905)	*12.0*	*5.56*	*3.1*
Mexico (1910)	24.3	2.57	10.5
Argentina (1913)	20.6	3.63	6.7
Uruguay (1912–1913)	3.8	1.44	3.7
Nigeria (1909)	1.2	0.15	9.5
Nigeria (1925)	6.1	0.58	11.5
Sierra Leone (1925)	2.7	0.66	5.2
Gold Coast (1909)	0.8	0.56	2.3
Gold Coast (1924–1925)	5.9	1.60	4.7

Source: For the Cape Colony, see Table 3. For other countries, Herranz-Loncán (2014) and Chaves et al. (2013).

3.2 Passenger traffic

Besides freight, we also estimated the social savings of rail passenger transport. As is customary in this kind of exercise, this should take into account people's savings not only in transport fares but also in time. The required time to travel would be much longer in a counterfactual economy without railways, due to the lower speed of the alternative transport means, and the opportunity cost of this additional travel time (in terms of foregone wages of the lost working time, for instance) should be added to the social saving calculation. To calculate time savings, though, we need to make some assumption about the share of traveling time that would be deducted from the passengers' working time in the absence of railways. Unfortunately, no specific information exists on the reasons for individual journeys, and previous social saving studies have adopted very different assumptions. For instance, while Hawke's (1970) estimation for England and Wales excluded the value of time, under the assumption that most traffic was for pleasure, for 1890 Boyd and Walton (1972) treated all travel time as working time and valued it accordingly. In the case of Mexico, Brazil, Russia, Spain and Uruguay, it is assumed instead that only about half of the time savings should be included in the estimation (Coatsworth 1979; Summerhill 2003; Metzer 1977; Herranz-Loncán 2006, 2011). Here we decided to keep the latter assumption; although pleasure journeys would be rather rare in the Cape Colony, there were some railway routes clearly associated with leisure activities in the neighborhood of Cape Town. In addition, one must consider all "passengers whose income was not a function of hours of work, and those who could do some work whilst being on the way" (Metzer 1977, p. 60). In the Appendix we show, though, the sensitivity of the social saving estimates to the alternative assumptions that potential working time was 0 and 100 percent, respectively, of the additional travel time in the counterfactual economy.

In order to complete the estimation, we had to introduce two additional assumptions, also inspired by previous literature: i) in the absence of railways, first-class passengers would have used stagecoach transport and second and third class passengers would have used carts or horseback, or walked; ii) the value of the working travel time of second and third class passengers can be estimated as the average hourly wage of unskilled workers, and that of first-class passengers as the average hourly wage of skilled workers. Similar assumptions have been made, for instance, in social saving estimates available for other peripheral economies, such as Mexico, Brazil and Uruguay (Coatsworth 1979; Summerhill 2003; Herranz-Loncán 2011); the sensitivity of the estimation to these assumptions is also shown in the Appendix.

Table 5 shows that the passenger transport social saving (not adjusted to the elasticity of demand) that results from applying these assumptions amounted to 5.2 percent of GDP in 1905. As in the case of freight, this estimate has a significant error margin, as can be seen in the sensitivity analyses included in the Appendix. However, we keep it as the most comparable one to other available studies for peripheral economies. In this regard, our passenger social saving estimate is rather high, compared with countries like Argentina, Mexico or Brazil, where it ranged from 2 to 4.4 percent, and other sub-Saharan African economies, where it was negative (Chaves *et al*. 2013; Herranz-Loncán 2014). As happened in the case of freight, the main reason for the high level of passenger social savings in the Cape is the volume of railway traffic. The ratio of passenger rail output to GDP in the Colony was almost three times as high as the average of the same ratio in Argentina, Brazil, Mexico and Uruguay by the same time.[18] In per capita terms, rail passenger-miles were 2.16 times as high in the Cape as in the average of those four Latin American countries. Thus, both in the case of freight and passengers, economic agents in the Cape tended to use railways with much higher intensity than in other primary exporting economies with similar development levels.

[18] Substituting this Latin American average for the true Cape Colony ratio in our calculation would yield a passenger social saving estimate of just 1.8 percent of GDP. As in the case of freight, other factors were much less relevant in determining the differential level of social savings in the Cape, compared with Latin America. For instance, using the average Latin American ratio between stagecoach and rail fares in the calculation would bring the estimate down to just 4.0 of GDP, i.e. still in the upper band of the Latin American estimates.

Table 5: (Unadjusted) social saving of Cape Colony rail passenger transport (1905)

	1st class	2nd & 3rd class
a) Railway output (million passenger-miles)	70.771	253.710
b) Railway fare in £ per passenger-mile	0.0058	0.0032
c) Railway output (million £) (*a x b*)	0.408	0.802
d) Unit value of working travel time in £ per hour	0.0523	0.0214
e) Rail passenger transport average speed (mph)	17.13	17.13
f) Working travel time by rail (million hours) (50% of *a* at *e* mph)	2.066	7.405
g) Value of working travel time by rail (million £) (*d x f*)	0.108	0.158
h) Counterfactual road transport output (million passenger-miles)	70.771	253.710
i) Counterfactual road transport price in £ per passenger-mile)	0.029	-
j) Counterfactual road transport output (million £) (*h x i*)	2.043	-
k) Road passenger transport average speed (mph)	7	2
l) Working travel time by road transport (million hours) (50% of *h* at *k* mph)	5.055	63.427
m) Value of working travel time by road transport (million £) (*d x l*)	0.264	1.357
n) Saving on transport costs (million £) (*j – c*)	1.635	-0.802
o) Saving on travel time (million £) (*m – g*)	0.156	1.199
p) Total savings (million £) (n + o)	*1.791*	*0.397*
q) As % of GDP	*4.26*	*0.95*

Sources and notes:

- Aggregate passenger railway output and rates come from the *Report of the General Manager for the year 1905*. To calculate the specific rates and output for each class, we use the ratios between rates for different classes in a sample of long-distance lines between 1903 and 1910, taken from the *Statistical Register*.
- Railway speed by 1905 has been estimated from a sample of 200 train service schedules, taken from the *CGR Official Pocket Time Table and Diary* for November 1904. The unit values of working travel time are averages of wages for various classes of (skilled or unskilled) workers in the Cape Colony in 1904, from De Zwart (2011) (we thank Pim de Zwart for providing us with the original wage data). We assume 10 daily working hours. Walking speed is as in Herranz-Loncán (2014).
- The stagecoach rate is estimated on the basis of a sample of 158 stagecoach rates included in the *CGR Official Pocket Time Table and Diary* for November 1904 (we excluded extreme outliers from the calculation). Although these fares correspond to secondary roads, the resulting rate is consistent with some scattered evidence on stagecoach prices in some main routes before the arrival of the railway, such as the trip between Kimberley and Johannesburg in the late 1880s (Beet 1924, p. 255) and the much shorter trip between Robertson and Worcester (Rhind 1995, p. 13). The speed of stagecoaches is assumed to be seven miles per hour, as indicated in Burman (1984, p. 12) for short trips from Cape Town before the railway. This speed would be consistent with the time schedule of travel between Kimberley and Johannesburg before the railway (allowing for night stops).

3.3 From social savings to additional consumer surplus

The sum of our estimates of freight and passenger social savings in 1905 amounts to £7.23 million, or 17.2 percent of the Colony's GDP. This is an upward biased estimate (due to the assumption of null demand elasticity) of the additional consumer surplus that the economy obtained from the railway. To get an unbiased estimate of that surplus, these figures must be corrected by the elasticity of demand of freight and passenger transport. Unfortunately, there is no information on unit prices and quantities (ton-miles and passenger-miles) transported by the CGR before 1903, and the sample of available observations (1903–1908) is too small to allow estimating a demand function. As a second-best option, for freight we use a set of elasticity

estimates for a number of Latin American primary exporting countries in the same period, which range from -0.5 to -0.8 (Coatsworth 1981; Summerhill 2000, 2003; Herranz-Loncán 2011). For passengers, following Herranz-Loncán (2014), we assume that transport demand elasticity was approximately -1 for the first class (since rail travel had a certain luxury component)[19] and that, in the absence of railways, all second and third class passengers would still have travelled by some means, because they journeyed mainly from necessity. This would be equivalent to assuming a null elasticity to the increasing cost of traveling for the lower classes. The estimates of consumer surplus of rail freight and passenger transport that result from applying these elasticities to the social saving figures are shown in table 6.[20] According to these figures, the aggregate consumer surplus of freight and passenger transport of the Cape railways can be estimated as 10.0 to 11.4 percent of GDP.

Table 6: (Elasticity of demand adjusted) additional consumer surplus of Cape Colony rail transport (1905)

Additional consumer surplus of rail freight (million £)	3.020/3.631
Additional consumer surplus of first-class rail passenger transport (million £)	0.774
Additional consumer surplus of second and third-class rail passenger transport (million £)	0.397
Total	*4.191/4.801*
As % of GDP	*10.0/11.4*

Sources: See text.

3.4. Company surplus and total direct income gains for the economy

To measure the total direct income gain the Cape economy obtained from the railway, we should increase these figures by the amount of supernormal profits (net of opportunity cost and amortization of capital) that accrued to the railway company. These correction would account for the effects on aggregate welfare gains of the difference between the actual railway rates and those that would have been established under competitive conditions. An estimation of supernormal profits requires information on CGR's net operating revenues and capital value, as well as some assumption on the opportunity cost and depreciation rate of capital.

The CGR's *Reports of the General Manager* provide the accounting value of capital for each year since the establishment of the company. These figures do not correspond exactly to the actual value of capital, due to the double-account system prevailing in railway companies up to the early 20th century, which usually excluded the application of a systematic depreciation rate

[19] See also Boyd y Walton (1972, pp. 247-150) and Metzer (1977, p. 73).

[20] The ratio of the additional consumer surplus to the social savings is given by $[(\phi^{1-\varepsilon}-1)/(1-\varepsilon)(\phi-1)]$, where ε is the absolute value of the elasticity of transport demand and ϕ is the ratio of alternative transport prices to rail transport prices; see Fogel (1979) and Leunig (2010).

on capital figures (see e.g. Glynn 1984). Instead, it was assumed at the time that asset renewal and betterment expenditures (which were included in different categories of current expenses, sometimes under the heading "depreciation") would make up for the capital wear and tear and obsolescence, keeping thus its value stable. The reported figure, therefore, gives the best available approximation to the actual value of capital, although it does not reflect its exact value because capital depreciation and renewal and betterment expenditures could have differed by an unknown magnitude between the beginning of railway construction and 1905. As in previous research on the topic by other authors (see e.g. Mitchell et al. 2010), here we use it as a proxy for capital value.[21]

CGR's invested capital was £29.97 million in 1905. This was equivalent to a construction cost of 10,034 pounds per mile, a figure that was in line with average railway construction costs in non-European countries.[22] The same year, net operating revenues amounted to £1.07 million, i.e. 3.6 percent of capital. Under perfectly competitive conditions, this percentage should have been roughly equivalent to the opportunity cost of capital and the amortization of equipment and infrastructure, net of renewal and betterment expenditures.

Following Mitchell et al. (2010, p. 826), the opportunity cost of capital might be estimated as:

$$CC = \lambda\,(rf + dp) + (1-\lambda)\,(rf + \beta rp) \qquad (6)$$

where λ is the leverage ratio, rf is the risk-free interest rate, dp is the debt premium, rp is the equity risk premium, and β is the ratio of the covariance of the returns on the company's shares with those of the overall market, divided by the variance of the market returns. In the case of the CGR, all capital was raised through government debt issues, with brought the leverage ratio to 1. This reduces expression (6) to the term *(rf + dp)*, which Mitchell et al. (2010, p. 827) estimate as ca. 4 percent in their analysis of the British railways. This figure is very close to the actual interest paid by the Cape railway government bonds, which was 3.7 percent in 1905, and that we adopt here as representative of the actual opportunity cost of the Cape railway capital.[23] On the other hand, on the basis of previous research for other countries, we assume a yearly

[21] The yearly growth rate of the capital series between 1873 and 1908 (7.7%) is very similar to the network mileage growth rate (8%).

[22] Webb (1911, pp. 512-513) provides figures of railway construction costs (in pounds per mile) for several world countries in 1905-1907. The average cost for 10 non-European economies was 11,385. Railways were much more costly in the core European economies, due to the much higher density of use of the network. For instance, they amounted to 56,000 pounds per mile in the UK, 34,600 in Belgium, 28,600 in France and 21,400 in Germany.

[23] While other peripheral countries' railways bonds gave much higher returns (often around 6 percent), these were associated to higher risk premia than in the Cape, which benefitted from the reputational benefits associated to the British colonial link.

depreciation rate of 1.7 to 2 percent (Fishlow 1965; Mercer 1982; Herranz-Loncán 2006). Table 7 shows the supernormal "profit" estimates that result from those assumptions, which are actually negative. The sum of these losses and the consumer surplus in Table 6 represent the Cape economy's entire direct income gain from railways in 1905, which amounted to £3.92 to £4.62 million, or 9.3 to 11.0 percent of the colony's GDP. This would also be equivalent to the rise in total factor productivity directly provided by the railway from 1873 to 1905.

Table 7: Supernormal "profits" of Cape railway transport (1905)

a) Capital value (million £)	29.973
b) Opportunity cost of capital (million £) (3.7% of a)	1.109
c) Depreciation (million £) (1.7% / 2% of a)	0.510 / 0.599
d) Total capital costs (million £) (b+c)	1.619 / 1.708
e) Renewal and betterment expenses (million £)	0.367
f) Net operating revenues (million £)	1.073
Supernormal "profits" (million £) (f-d+e)	*-0.179 / -0.268*
As a % of GDP	*-0.43 / -0.64*

Sources: Report of the General Manager for the year 1908; for the depreciation rate, see text.

Growth accounting allows measuring the significance of those aggregate gains in the Cape economic growth since the beginning of railway operation. If we calculate the increase in the Cape's GDP between 1873 and 1905 and extract from it the share that is merely labor accumulation, the rest represents the Cape's aggregate increase in labor productivity over that period. According to the usual growth accounting decomposition, labor productivity growth is the combined result of increasing capital per capita and TFP gains. We can therefore estimate the total direct contribution of the railway to the Colony's labor productivity growth as the sum of railway TFP gains (sum of the estimates presented in Tables 6 and 7) and the impact on labor productivity of railway capital accumulation. To estimate the latter, the per capita growth rate of railway capital should be multiplied by the factor income share of railway capital, i.e. the average ratio of railway net revenues to nominal GDP from 1873 to 1905. Table 8 presents the result of those calculations.

Table 8: Railway contribution to the Cape's labour productivity growth between 1873 and 1905

1. TFP contribution	
a) Railway TFP gains (million £ of 1905)	3.922/4.623
b) Total growth of Cape's labour productivity, 1873-1905 (million £ of 1905)	25.612
c) Railway TFP contribution to labour productivity growth, 1873-1905 (a/b) (%)	*15.31/18.05*
2. Capital contribution	
d) Railway capital per capita yearly growth rate, 1873-1905 (%)	4.06
e) Average factor income share of railway capital, 1873-1905 (%)	3.84
f) Railway capital contribution to labour productivity growth in points of yearly growth, 1873-1905 (d x e) (%)	0.16
g) Cape's labour productivity yearly growth rate, 1873-1905 (%)	2.21
h) Railway capital contribution to labour productivity growth, 1873-1905 (f/g) (%)	*7.04*
3. Total railway contribution to labour productivity growth, 1873-1905 (c + h) (%)	*22.35/25.09*

Sources and notes:

a) Railway TFP gains: Table 6 and 7.

b) Total growth of Cape's labour productivity is estimated as: (GDP_{1905}-GDP_{1873}) – ($Pop._{1905}$ x pc GDP_{1873} - GDP_{1873}). For simplicity we assume that the growth rates of labor productivity and per capita GDP were the same. Real GDP is estimated on the basis of GDP and CPI figures from Verhoef et al. (2014) and population figures come from a yearly interpolation between population census figures, taken from the *Official Year-Book.*

d) Railway capital growth: estimated from yearly data taken from the *Report of the General Manager for the year 1908.*

e) Railway factor income share: estimated as the average ratio, over the period 1873-1905, between net operating revenues (from the *Report of the General Manager for the year 1908*) and nominal GDP from Verhoef et al. (2014).

Thus, the railway directly accounted for approximately 22 to 25 percent of the increase in income per capita or labor productivity in the Cape Colony between the beginning of the railway era and the end of the diamond boom. Despite the relatively high error margin of this figure, due to insufficient empirical data and the numerous assumptions introduced in the estimation, it is a fairly robust indication of the essential role that railways played in the growth and transformation of the Cape's economy during this period. Moreover, this figure excludes the indirect effects of the railway, such as agglomeration economies arising from the urban concentrations that railways made possible, or productivity growth associated to increasing demand for transport inputs, via backward linkages. So, economic growth in the Cape Colony during the first globalization seems to have been, to a significant extent, directly associated with investment in the railway.

But, were railway social gains sufficient to justify the amount of capital invested? Comparing our estimate of railway social gains for 1905 with the value of capital we can obtain the social rate of return for that year. Although this cannot replace a complete estimate of the social rate of return for the whole life of operation of the railway system, or at least for a sufficiently long period, it may at least provide a preliminary approach to the levels the rate reached during the diamond cycle. Since the value of railway capital was £29.97 million in 1905 (see above), the social returns of the railways that year represented a respectable 13.1 to 15.4 percent of the

capital invested. These figures are in line with the social returns of railways in other countries with low population density, such as the US and Brazil, and are much higher than those estimated for Canada and Uruguay (Mercer 1982; Carlos and Lewis 1992; Summerhill 2003; Díaz Steinberg 2016).[24] Given that our estimate of railway benefits excludes all potential indirect effects, it seems safe to say that the Cape economy obtained quite satisfactory social returns from the capital invested in the rail network.[25]

4. Railways, colonial government and local development

The Cape Government Railways provided substantial social benefits to the economy. The company's returns, however, were much more moderate. We have shown that in 1905 net operating revenues were not enough to cover the opportunity cost and amortization of capital, and this situation was not rare during the company's life. Taking the whole period 1873-1908 together, net operating returns were on average 3.7 percent of capital. Such low returns are consistent with the low population density and the settler character of the Cape Colony. Although not strictly comparable with more rigorous estimates of internal rates of return available for other sparsely populated countries, an average return of 3.7 percent of capital is similar to estimates for Canada, Uruguay and some US and Brazilian lines with low railway profitability (Mercer 1982; Carlos and Lewis 1992; Summerhill 2003; Díaz Steinberg 2016). However, it meant that the Cape railways often represented a financial burden for the Cape colonial government, the owner of almost the whole network since 1872.

CGR's financial surplus can be estimated as the difference between net operating revenue and interest charges on railway capital.[26] All CGR capital was debt funded, coming from successive government bond issues. It was largely raised by the Cape government in London, although occasionally some local loans were floated, usually when it was considered advisable to stay away of the British market, in order to allow the absorption of previous issues in London, or to give British investors a signal of confidence of the Cape elites in their own government (Purkin

[24] The significance of this comparison depends on the representativeness of the Cape railways' social rate of return in 1905 for their whole operating period (1873–1910). As has been reported before, the ratio of CGR net operating revenues to accounting capital in 1905 was 3.6 percent, very similar to the average over the period 1873–1908 (3.7 percent).

[25] A thorough assessment of the social profitability of railways should be based on a comparison of those figures with the returns that might have been obtained by investing the same amount of capital elsewhere. However, it is difficult to imagine any other large project which, as a whole, could have given comparable benefits to the economy.

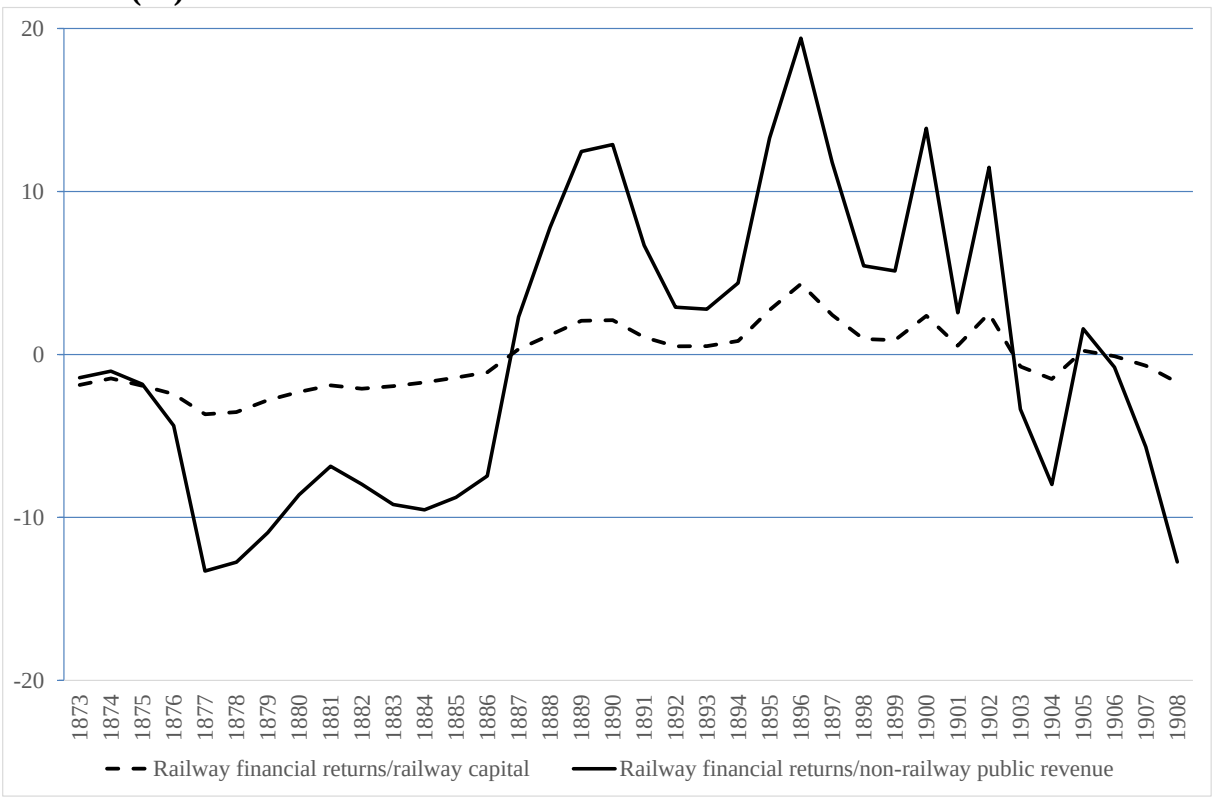
[26] We assume that renewal and betterment expenditures were in line with amortization needs.

1978, p 282).[27] Thanks largely to the effect of the colonial link, returns to CGR railway debt issues were relatively low, fluctuating from 3 to 5 percent between 1873 and 1909. They actually tended to decrease over time, from levels of around 4.5 percent during the 1870s and 1880s (Purkins 1978; p. 270) to levels ca. 3.5 percent in the late 1900s.

The *Statistical Register* only provides exact figures of railway interest charges for the last years of the company's life. Between 1882 and 1906-07 the available sources give instead aggregate data on the interest paid to the whole Cape government debt.[28] We have therefore estimated a series of railway interest payments for 1873-1882 by assuming that they were 4.5 percent of railway capital before 1882, as suggested by Purkins (1978).[29] We have then linked the 1882 and 1907 figures by assuming a linear evolution in the ratio between railway interest payments and total public debt interest charges between those two years.[30] The difference between net operating revenues and our series of railway interest payments would represent the net financial surplus of the company. We show this series in Figure 6, as a percentage of both railway capital and non-railway government revenues.[31]

[27] Railway capital raised in the local market until 1885 accounted for just 3.2% of the total (Purkin 1978, pp. 280-281); this percentage would have increased until ca. 9% in later issues (data for the whole Cape government debt; *Statistical Register for 1909*, p. 68).
[28] Data taken from the *Statistical Register* for 1909 and the *Blue Books* for 1883, 1892 and 1901.
[29] This percentage is consistent with the interest rates reported for the debt issues of those years in the *Statistical Register* for 1909, although the detail provided there is insufficient to make an exact calculation.
[30] Railway interest charges were 45 percent of total public debt interest paid in 1882, and 62 percent in 1907. We have transformed the interest charges figures from budget to calendar years assuming that payments were equally distributed along the budget year. The resulting series is consistent with an interest rate on railway debt fluctuating between 3.5 and 4.5 percent during the company's life.
[31] Non-railway revenues are the difference between total government revenues and CGR's gross revenues (CGR accounts were fully integrated in the colonial government budget). Those data are taken from the *Statistical Register for 1909*. As in the case of interest, we assume that revenues were equally distributed along the budget year.

Figure 6: CGR's financial returns as a percentage of capital and non-railway government revenues (%)



Sources and notes: see text.

Figure 6 shows an alternation of periods with positive and negative financial surpluses. Until 1886, these were negative, and CGR represented a financial burden for the colonial budget, which had to devote part of its ordinary resources to compensate foreign investors. Negative returns are typical of early railway networks, before they reach their maturity and the main links are completed. During those years, on average, the government had to use ca. 7 percent of their non-railway revenues to cover the CGR's financial deficit. The situation was totally opposite between 1887 and 1902, during the peak of the diamond cycle and after the completion of the main railway connection to Kimberley. In that period CGR's revenues boomed, and the company became a source of net revenue for the government. On average, the railways increased the colony's revenue budget by an average of 8 percent during those years. The situation, however, changed when the diamond peak and the Boer War came to an end, and from 1903 onwards the railways represented again a burden to the government, equivalent to ca. 5 percent of non-railway revenues.

Taken together the whole CGR's life, returns seem to have been slightly positive but small. The average ratio between railway financial surpluses and non-railway government revenues over 1873-1908 was only 0.05 percent, and the 1908 present value of the sum of (positive and negative) net railway returns over 1873-1908 was £0.99 million, i.e. 2 percent of the Cape GDP

in 1908.[32] The government probably obtained much higher benefits from the railway through the effects that the Colony's increasing wealth had on certain categories of public revenues, such as customs receipts (which were on average 50 percent of non-railway revenues between 1873 and 1908) or taxes on land on mines, which grew substantially during the period. As far as the railways had a relevant role in the take-off of the Cape mining export economy, and therefore in the Colony's capacity to import, they would also have contributed to a significant increase in the colonial government's receipts.[33]

The Cape government was aware that the main effects of the railways would come through the Colony's development. An analysis of the parliamentary debates from 1870 to 1895 indicate that the possibility of CGR to become a stable direct source of revenue for the government was never seriously considered, rather the opposite. Apparently the prevailing opinion matched that of MP Robert Godlonton (cited at the start of this paper) in the early discussions about acquiring the Wellington railway: the railways were for the public benefit rather than for profit. Most references to the railway in the *Debates* during the last decades of the nineteenth century describe it as a powerful instrument of growth and development, essential for the exploitation and export of the country's natural resources, particularly its minerals, which were key to the Colony's prosperity. The railways would not only bring in export revenue but would also boost the farming districts that supplied the mines. They were thus expected to have positive effects on land values, output, immigration and the occupation of empty land.[34]

By contrast, we can find no reference whatsoever in the *Debates* to their potential to generate government revenue, and almost no mention of political or administrative objectives that the railway system might serve. Only occasionally did members of the Legislative Council allude to the military interest of some specific lines, usually to reinforce a claim about their economic importance. And from the early 1890s, on several occasions the extension towards the Free State and the Transvaal was described as a means to unify South Africa. Regarding the line from Port Elizabeth to Bloemfontein, MP Mr. Bowker noted that "the time was not far distant when all the Colonies and States of South Africa would be one people", and the best way to bring this about was to vote for this proposed extension.[35]

[32] We assume a 4 percent discount rate, which would be an approximation to the average public debt interest rate during the period.
[33] Data on customs and other revenue sources are available in the successive edition of the *Statistical Register* and the *Blue Books*. For the indirect impact of railways on imports and government revenues in Latin America see Bignon et al. (2015).
[34] For instance, *Debates*, Vol. III (1870), p. 79-87, 93, 237-241; Vol. IV (1871), p. 22, 24, 27; Vol. V (1872), p. 148, 152, 194; Vol. VI (1873), p. 73, 77-79, Vol. XV (1881), p. 21; Vol. XIX (1885), p. 19; Vol. XXIII (1889), p. 137, 140, 152; Vol. XXIV (1890), p. 152; Vol. XXIX (1895), p. 270-271, 278. See also Purkin (1978), pp. 45-48.
[35] *Debates*, Vol. XXIV (1890), p. 157.

The Cape Parliament's lack of concern about the financial profitability of prospective railways would have some features in common with Australian railway politics under the so-called "colonial socialism". In Australia since the late 1870s, and thanks largely to the easy access to British capital, the most widespread opinion among citizens and their representatives seems to have been that railways brought social and economic benefits that justified their construction even if investment could not be recovered through traffic revenues. According to Boot (1996, p. 91), in Australia: "A concern for profitability soon gave way to an emphasis on less quantifiable, though politically easily justified, social and general economic considerations (…). By the mid-1880s, when even these vague criteria had been abandoned to permit extensions of railway networks for political ends, prospective economic returns had become largely irrelevant to expenditure decisions. Aggregate revenues from the railways did not even cover running costs and the interest on the money borrowed to build them".[36]

In the case of the Cape Colony, the available evidence in the parliamentary debates would point in a similar direction, since they were much more focused on the general social and economic benefits of infrastructure than on rigorous considerations about financial sustainability. The railway was seen as an engine of development for the territories it crossed and, in that context, MPs made their best to bring railway investment to their own constituencies, regardless of any profitability estimation. No district wanted to be deprived of the railway, since without it, as MP Mr Wilmot observed, "their land must lie dormant" and "neither development nor prosperity [would be] possible".[37] Bringing the railway to certain districts to stimulate their economy was justified even if it might burden the government budget. This was actually the position of Prime Minister Cecil John Rhodes, who stated before the Legislative Council, regarding a railway extension project, that the government "did not expect these railways to pay large interest on the capital expended" and "would be content if they paid their working expenses and [gave] those very promising districts a chance of development".[38]

In other words, there was room for the construction of unprofitable railways for the benefit of specific districts. This "developmental" approach to railways may partially explain CGR's low returns. And we can easily understand why debates on railway routes in the Legislative Council between MPs coming from of different regions, and specifically between Western and Eastern Cape representatives often became heated. For instance, in response to a proposal that the Cape Government be authorized to confer with the governments of the Orange River Colony and the

[36] See also Davis and Gallman (2001, p. 484) and, for the concept of "colonial socialism", Butlin (1959).
[37] *Debates*, Vol. XXIX (1895), p. 269.
[38] *Debates*, Vol. XXIX (1895), p. 278.

Transvaal to discuss the best northern route for the railways, MP Mr. Joubert warned that the Cape Government should attach "some weight to the point whence the line should be extended". In the alternative between a shorter connection between the Transvaal and the Eastern Cape (Port Elizabeth) and a longer link with Cape Town, he argued that finding the shortest (and probably most profitable) route was not the only object: as the western districts produced more than the eastern, more freight could be obtained if the western line were extended. If this were not done, only European importers would benefit.[39]

It seems therefore that the Cape parliament was fully aware of the potential distributional effects of railway policy decisions. Thus, when the Commissioner of Crown Lands and Public Works tabled the Railways Bill on 13 June 1881, a bill that would extend the trunk line from Cape Town into Griqualand West (i.e. the Kimberley area), he noted that the "position of the colonial railway was remarkably encouraging" and that "the government was justified in coming to parliament and proposing additional railway expenditure". He said there was "very great demand in the country for an extension of the railway system, especially to Griqualand West", because the whole Colony had "shared in the advantages which had been derived from Griqualand".[40] In response, MP Mr. Burger objected to the way the trunk lines were to be extended, particularly when he found that the government proposals "would be most favorable to an already highly privileged part of the Colony, and in this way an injustice was done to a long and shamefully neglected portion of it".[41]

The *Debates* provide some scattered evidence of the lobbying activities of certain districts and sectors. For instance, we find evidence of the influence of mining interests in a discussion about completing the trunk line between Cape Town and Kimberley. In 1884 the Orange River and Kimberley Railway Bill was tabled in parliament to allow a private company to construct the remainder of the line. Mr. Upington summarized the reason for this Bill. An attempt had been made to induce the government to pay for the construction of the line from the Orange River to Kimberley, but the government had declined to continue the construction using public funds. Pressure was then brought to bear on the government "by persons connected with the Mining and other industries in Kimberley", who said "it would be of the greatest possible advantage to them to have the railway constructed to Kimberley" and asked the government "to grant them an empowering Bill".[42]

[39] *Debates*, Vol. XXI (1887), pp. 129–30.
[40] *Debates*, Volume XV (1881), p. 116.
[41] *Debates*, Volume XV (1881), p. 118.
[42] *Debates*, Volume XVIII (1884), p. 231.

Although the names of these "persons" are not recorded, it is probable that Rhodes was involved. He had moved to the diamond fields in 1871 and built up a business empire that led to the establishment of De Beers Consolidated Mines in 1888. But he was also active in politics, becoming a member of the Cape parliament in 1880 and Prime Minister in 1890. Given his interests in the diamond mines, he might well have lobbied for completion of the last part of the line to Kimberley. But similar links could also be found to certain farming interests. In 1877 MP Mr. Neethling noted angrily that he had "always thought that the present Government would sympathize with the farming population, because more than one member of the Cabinet was connected with agriculture".[43]

The estimates presented in Section 3 confirm that the prevailing expectations of high railway social benefits were largely justified. On the aggregate, railway investment paid off and had a central role in the Colony's productivity growth. To make a thorough estimate of its impact at the local level is beyond the objectives of this paper. However, we can use the detailed traffic information by station and freight category provided by the *Report of the General Manager* for 1905 to identify the districts that generated most railway traffic. This allows making a preliminary approach to the way in which the different regions of the colony responded to the specialization opportunities offered by transport cost reduction and market integration.

The first thing we note from these data is the centrality of the Kimberley diamond fields in the railway system. Apart from Cape Town, Port Elizabeth and East London, the three main international ports, in 1905 Kimberley was the station that generated by far the highest revenue. This was mainly associated to inward traffic, since the Kimberley district received much more freight than it supplied. The very high value-to-weight ratio of diamonds meant that a cheap transport method was needed not so much to dispatch the product as to supply the mining fields with industrial commodities, construction materials, fuel and foodstuffs. In other words, railways were necessary to support a growing settlement around the mines. Even in 1905, when the peak of the diamond cycle had passed, traffic data indicate that the Cape rail network was used mostly to supply Kimberley district.

Traffic data allow estimating railway traffic balances by district and commodity as the difference between all outward traffic dispatched from the stations of the district and all inward traffic received by them. By 1905 the Kimberley district, with just 2.5 percent of the Colony's

[43] *Debates*, Vol. X (1877), p. 278. On railway lobbying in the Cape Colony in the 1870s and 1880s, see also Purkin (1978).

population,[44] was the destination of very high percentages of certain categories of rail freight. It had negative balances in almost all categories, and in each of them its net inward traffic accounted for very high shares of the aggregate net inward traffic of all Cape Colony districts with deficit. For instance, Kimberley was the destination of 9 percent of all "general merchandise" (mainly imported industrial products) moved by the railway, 7 percent of South African-produced wines and spirits, 7 percent of "grain and cereal", 14 of all other South African agricultural produce, 17 percent of "flour, meal, malt and bran", 24 percent of timber, 52 percent of firewood, and an impressive 69 percent of "coal, coke and patent fuel". Looking at these figures another way, we find that per person in 1905 the Kimberley district received through the railway 460 kg of cereals, flour, meal, malt or bran, 14.5 kg of wine and spirits of South African origin, 265 kg of other agricultural produce, and 354 kg of firewood. These rail deliveries were sufficient to meet a very high share of the Kimberley population's consumption needs, which reflects the high dependence of the district on railway transport.

The railway, therefore, by reducing the effects of distance on trade costs, allowed Kimberley to grow on the basis of imports and domestic production from the rest of the Colony. Although we cannot say to what extent railways were indispensable for the growth of the Kimberley region, this was indeed made easier by the availability of less costly inputs, while cheaper transport probably contributed to avoid the potential risk of congestion that dependence on the supplying capacity of the closest regions would have involved.

In fact, the surrounding regions, which had benefitted from the Kimberley demand during the early years of the diamond boom, fell behind once the railway arrived to the mining fields. For instance, in the case of Basutoland, Keegan (1986, p. 200) noted that in the late 1870s "Basutoland quickly emerged as an indispensable provisioner of the Diamond Fields (…). The trains of laden transport wagons making their way through the Free State to the Diamond Fields were a common sight at the time". But railways soon brought competition, not only from the western parts of the Colony but also from America and Australia. In March 1887 Robert Germond, a missionary at Thabana Morena in Basutoland, noted that the railway had "profoundly modified" the region's economic situation. He said that Basutoland:

> produces less and finds no outlet for its products. Its normal markets, Kimberley and the Free State, purchase Australian and colonial wheat… Basutoland, we must admit, is a poor country… Last year's abundant harvest has found no outlet for, since the building

[44] Figure for 1904, taken from the *Statistical Register* for the year 1903.

> of the railway, colonial and foreign wheat have competed disastrously with the local produce. (Germond 1967, p. 469)

According to the traffic data, a large share of Kimberley consumption needs were covered by imports. For instance, 61 percent of the "flour, meal, malt & bran" or 76 percent of the timber that arrived to the district was imported. However, in other categories like "grain and cereal" and "coal, coke and patent fuel", almost 100 percent of consumption was covered by South African produce.[45] The growth of Kimberley, therefore, represented a significant demand pull for those areas of the Colony with the necessary resources to become suppliers of domestic consumption needs. In this regard, traffic data show that, for many categories and, specially, agricultural products, the main domestic suppliers were a small number of Western districts in the vicinity of Cape Town. These districts, accounting for around 10 percent of the population and surface area of the Colony, stood out among the main beneficiaries of the market integration that accompanied the mining export boom, despite their distance from the diamond fields.[46] Western Cape districts' deliveries to the rest of the Colony through the railways accounted for 97 percent of all districts' deliveries in the case of wine, 88 percent for spirits, 48 percent for grain and cereals, 54 percent for flour, meal, malt, and bran, 86 percent for other agricultural products, and 82 percent for "bricks and ashes". Except for the latter, these districts were less important as providers of non-agricultural products, such as timber (18 percent), firewood (7 percent), and coal (0 percent). And they also fell behind in the production of some of the main exports of the colony, such as "wool and mohair" (9 percent) and "skins, hides, horns and ivory" (16 percent), items in which the Eastern Cape production was absolutely dominant.

This structure of traffic reflects a specialization of the different regions and the different sections of the railway network. While the Western system (the route between Cape Town and Kimberley and its branch lines) largely specialized in the distribution of domestic production (and to a lesser extent imports) to the interior, in order to meet the consumption needs of the diamond fields and other areas of the Colony, the Midland and Eastern systems (the routes connecting Port Elizabeth and East London to the North) seem to have been much more focused

[45] CGR's traffic data do not distinguish between production from the Cape Colony and from the rest of South Africa; in other words, part of the South African grain or coal consumed in Kimberley was not produced in the Cape. This is confirmed by the significant presence among the supplying districts of some items of port and border districts.

[46] Those districts were Caledon, Laingsburg, Malmesbury, Oudtshoorn, Paarl, Piquetberg, Prince Albert, Riversdale, Robertson, Simonstown, Stellenbosch, Steynsburg, Swellendam, Tulbagh and Worcester. We have not included Cape Town in the list, as a large number of railway deliveries coming from that districts were not domestically produced but arrived there by sea.

on the transport of (non-mining) exports and imports. By 1905 all sections of the system had a rather similar level of use, but carried quite different products.[47]

As described in Purkin (1978), this structure of interregional relations and transport flows was very different from the pre-railway one. By the early 1870s, Port Elizabeth was the main commercial center of the Cape, and the Kimberley area was considered as part of its hinterland. Commodity trade between the Western Cape and the diamond fields was limited by long distance and the need to cross the semi-desert Karoo area. Only the direct railway connection between Cape Town and Kimberley, which was felt like a defeat by the (politically underrepresented) merchant community in Port Elizabeth, allowed the Western Cape to benefit from the most important source of demand of the Colony, substantially reducing the role of the Eastern districts or, for the same reason, Basutoland, as suppliers of domestic produce.

Although it is beyond the scope of this research to produce social saving estimates for specific regions, the comparison between the economic geography of the colony before and after the construction of railways indicate that the social gains of the Cape railways benefited the Western areas more than the Eastern ones, through the opening of previously absent economic opportunities. Recent research has found persistent spatial effects of railways in other African countries (Jedwab *et al*. 2016; Jedwab and Moradi 2016). Although it would require more micro-level evidence to infer the precise causal impact, Cape railway policy may have had a similarly differential long-term effect on the further evolution of income per capita in the different regions of the country.

5. Conclusion

From the mid-nineteenth century, globalization and the discovery of diamonds at Kimberley transformed the Cape Colony into a prosperous exporting region with a steadily increasing GDP and eventually one of the largest and densest rail networks on the continent. By reducing transport costs to the interior, the railway eased the movement of labor and goods to the diamond fields, and later to the Transvaal goldfields. Their contribution to economic growth was substantial: we estimate that railway may explain about 22 to 25 percent of the increase in income per capita in the Cape during the diamond-mining period (1873–1905). This is a very

[47] Revenues per mile of line in 1905 were very similar in the three systems: £976 in the Western System, £1103 in the Midland System, and £979 in the Western System; *Report of the General Manager for the year 1905.*

large share for a single investment and a clear indicator of the transformative power of the railways.

However, in contrast with the railway's high social benefits, the Cape government railway company's returns hardly covered the amount the government invested. This was consistent with the prevailing perception in the Cape parliament of railways as a tool for local development, rather than as a source of revenues for the public company. In this regard, the available traffic data show that the railway might have been crucial for the growth of the diamond district, but also for the economic expansion of the Western Cape area. This could develop as supplier of the Colony's consumption needs, taking advantage of the opening of previously absent trade opportunities. The railway therefore not only accounted for a substantial share of the Cape economic growth but for a significant reorganization of trade flows and the distribution of activity.

References

Beet, G. (1924). Old coaching days in South Africa: Reminiscences of stirring times. In Weinthal, L. (ed.). *The Story of the Cape to Cairo Railway and River Route from 1887 to 1922*. Luton: Gibbs, Bamforth and Co.: pp. 239–67.

Bignon, V., Esteves, R. and Herranz-Loncán, A. (2015). Big push or big grab? Railways, government activism, and export growth in Latin America, 1865–1913. *Economic History Review* **68**, pp. 1277–305.

Bogart, D. (2010). A global perspective on railway inefficiency and the rise of state ownership, 1880–1912. *Explorations in Economic History* **47**, pp. 158–78.

Bogart, D. and Chaudhary, L. (2012). Regulation, ownership, and costs: A historical perspective from Indian railways. *American Economic Journal: Economic Policy* **4**, pp. 28–57.

Bogart, D. and Chaudhary, L. (2015). Off the rails: Is state ownership bad for productivity? *Journal of Comparative Economics* **43**, pp. 997–1013.

Bogart, D., Chaudhary, L. and Herranz-Loncán, A. (2015). The growth contribution of colonial Indian railways in comparative perspective. Unpublished research paper: University of California-Irvine.

Boot, H.M. (1996). Government and the Colonial Economies. *Australian Economic History Review* **38** (1), pp. 74-101.

Boshoff, W.H. and Fourie, J. (2016). When did South African markets integrate into the global economy? *Studies in Economics and Econometrics* (forthcoming).

Boyd, J. H. and Walton, G. M. (1972). The Social Savings from Nineteenth-Century Rail Passenger Services. *Explorations in Economic History* **9** (3), pp. 233-254.

Bundy, C. (1972). The emergence and decline of the South African peasantry. *African Affairs* **71**, pp. 369–88.

Buringh, E., Bosker, M. and Van Zanden, J.L. (2016). A new look at Roman sea freight rates. Diocletian's price edict reconsidered. Unpublished research paper.

Burman, J. (1984). *Early Railways at the Cape*. Cape Town: Human & Rousseau.

Butlin, N. G. (1959). Colonial Socialism in Australia,1860–1900. In Aitken, H. G. (ed.),*The State and Economic Growth.* New York: Social Science Research Council,1959.

Carlos, A.M. and Lewis, F. (1992). The profitability of early Canadian railways: Evidence from the Grand Trunk and Great Western railway companies. In Goldin, C. and Rockoff, H. (eds), *Strategic Factors in Nineteenth Century American Economic History: A Volume to Honor Robert W. Fogel*. Chicago: University of Chicago Press, pp. 401–26.

Chaves, I.N., Engerman, S.L. and Robinson, J.A. (2013). Reinventing the wheel: The economic benefits of wheeled transportation in early British Colonial West Africa. NBER (National Bureau of Economic Research) Working Paper 19673.

Cilliers, J. and Fourie, J. (2016). Social mobility during South African industrial take-off. ERSA (Economic Research Southern Africa) Working Paper 617.

Cilliers, J. and Mariotti, M. (2016). The fertile frontier: Differential fertility in a settler colony. Unpublished research paper: Stellenbosch University.

Coatsworth, J.H. (1979). Indispensable railroads in a backward economy: The case of Mexico. *Journal of Economic History* **39**, pp. 939–60.

Crafts, N.F.R. (2004). Social savings as a measure of the contribution of a new technology to economic growth. LSE Department of Economic History Working Paper 06/04.

Davis, L. E. and Gallman, R. E. (2001). *Evolving Financial Markets and International Capital Flows. Britain, the Americas, and Australia, 1865–1914*. Cambridge, Cambridge University Press.

De Zwart, P. (2011). South African living standards in global perspective, 1835–1910. *Economic History of Developing Regions* **26**, pp. 49–74.

Díaz Steinberg, G. (2016). Railway investment in Uruguay before 1914: Profitability, subsidies and economic impact. Unpublished research paper.

Donaldson, D. (2016). Railroads of the Raj: Estimating the impact of transportation infrastructure. *American Economic Review* (forthcoming).

Donaldson, D. and Hornbeck, R. (2016). Railroads and American economic growth: A "market access" approach. *Quarterly Journal of Economics* (forthcoming).

Eldredge, E. (1993). *A South African Kingdom: The Pursuit of Security in Nineteenth-Century Lesotho*. Cambridge: Cambridge University Press.

Fishlow, A. (1965). *American Railroads and the Transformation of the Antebellum Economy*. Cambridge, MA: Harvard University Press.

Fogel, R.W. (1964). *Railroads and American Economic Growth: Essays in Econometric History.* Baltimore, MD: John Hopkins Press.

Fogel, R.W. (1979). Notes on the social saving controversy. *Journal of Economic History* **39**, pp. 1–54.

Fourie, J., Inwood, K. and Mariotti, M. (2016). Can historical changes in military technology explain the industrial growth puzzle? Unpublished research paper: Stellenbosch University.

Germond, R. (1967). *Chronicles of Basutoland: a running commentary on the events of the years 1830-1902*. Morija, Lesotho: Morija Sesuto Book Depot.

Glynn, J. J. (1984). The Development of British Railway Accounting: 1800-1911. *Accounting Historians Journal*, 11 (1): 103-118.

Greyling, L. and Verhoef, G. (2015). Slow growth, supply shocks and structural change: The GDP of the Cape Colony in the late nineteenth century. *Economic History of Developing Regions* **30**, pp. 23–43.

Groote, Peter (1996), Infrastructure and Dutch Economic Development. A New Long Run Data Set for the Netherlands 1800-1913, Utrecht/Groningen, Koninklijk Nederlands Aardrijkskundig Genootschap/Faculteit der Ruimtelijke Wetenschappen.

Hawke, G. R. (1970). *Railways and Economic Growth in England and Wales*. Oxford: Clarendon Press.

Herranz-Loncán, A. (2006). Railroad impact on backward economies: Spain, 1850-1913. *Journal of Economic History* **66** (4), pp. 853-881.

Herranz-Loncán, A. (2011). The role of railways in export-led growth: The case of Uruguay, 1870–1913. *Economic History of Developing Regions* **26**, pp. 1–32.

Herranz-Loncán, A. (2014). Transport technology and economic expansion: The growth contribution of railways in Latin America before 1914. *Revista de Historia Económica - Journal of Iberian and Latin American Economic History* **32**, pp. 13–45.

Jedwab, R. and Moradi, A. (2016). The permanent effects of transportation revolutions in poor countries: Evidence from Africa. *Review of Economics and Statistics* **98**, pp. 268–84.

Jedwab, R., Kerby, E. and Moradi, A. (2016). History, path dependence and development: Evidence from colonial railroads, settlers and cities in Kenya. *Economic Journal* (forthcoming).

Juif, D., Baten, J. and Frankema, E. (2014). Numeracy of African groups in the 19th century Cape Colony: Racial segregation, missions and military privilege. Unpublished research paper.

Keegan, T. (1986). Trade, accumulation and impoverishment: Mercantile capital and the economic transformation of Lesotho and the conquered territory, 1870–1920. *Journal of Southern African Studies* **12**, pp. 196–216.

Leunig, T. (2010). Social savings. *Journal of Economic Surveys* **24**, pp. 775–800.

Mercer, L. (1982). *Railways and Land Grant Policy: A Study in Government Intervention.* Washington DC: Beard Books.

Metzer, J. (1977). *Some Economic Aspects of Railroad Development in Tsarist Russia*. New York: Arno Press.

Mitchell, B.R. (2003a). *International Historical Statistics: Africa, Asia and Oceania, 1750–2000.* Houndmills: Palgrave.

Mitchell, B.R. (2003b). *International Historical Statistics: The Americas, 1750–2000.* Houndmills: Palgrave.

Mitchell, B., Chambers, D., and Crafts, N. (2010). How good was the profitability of British railways, 1870-1912? *Economic History Review* **64**, 3, pp. 798-831.

Pirie, G.H. (1982). The decivilizing rails: Railways and underdevelopment in southern Africa. *Tijdschrift voor Economische en Sociale Geografie* **73**, pp. 221–28.

Pirie, G.H. (1993). Slaughter by steam: Railway subjugation of ox-wagon transport in the Eastern Cape and Transkei, 1886–1910. *The International Journal of African Historical Studies* **26**, pp. 319–43.

Ramírez, M.T. (2001). *Los ferrocarriles y su impacto sobre la economía colombiana*. *Revista de Historia Económica - Journal of Iberian and Latin American Economic History* **19**, pp. 81–122.

Rhind, D.M. (1995). *A Chronicle of the Cape Central Railway.* Cape Town: Railway History Group.

Ross, G.L.D. (1998). The interactive role of transportation in the economy of Namaqualand. Unpublished PhD thesis. Stellenbosch: University of Stellenbosch.

Summerhill, W.R. (1998) Market intervention in a backward economy: railway subsidy in Brazil, 1854-1913. *The Economic History Review* **51**, pp. 542–568.

Summerhill, W.R. (2003). *Order against Progress: Government, Foreign Investment, and Railroads in Brazil, 1854–1913.* Stanford, CA: Stanford University Press.

Summerhill, W.R. (2005). Big social savings in a small laggard economy: Railroad-led growth in Brazil. *Journal of Economic History* **65**, pp. 72–102.

Tang, J.P. (2014). Railroad expansion and industrialization: Evidence from Meiji Japan. *Journal of Economic History* **74**, pp. 863–86.

Temin, P. (2013). Statistics in ancient history. MIT Department of Economics working paper 13-06.

Verhoef, G., Greyling, L. and Mwamba, J. (2014). Savings and economic growth: A historical analysis of the relationship between savings and economic growth in the Cape Colony economy, 1850–1909. ERSA (Economic Research Southern Africa) working paper 408.

Webb, A. D. (1911). *The New Dictionary of Statistics. A Complement to the Fourth Edition of Mulhall's "Dictionary of Statistics"*. London: Routledge.

Zegarra, L.F. (2013). Transportation costs and the social savings of railroads in Latin America. The case of Peru. *Revista de Historia Económica - Journal of Iberian and Latin American Economic History* **31**, pp. 41–72.

Appendix. Sensitivity analyses of the social saving calculations

Table A.1. Freight transport

1. Railway economy	Original estimate	50% (highest) carting rate sample	50% (lowest) carting rate sample
a) Railway freight (million ton-miles)	361.03	361.03	361.03
b) Railway market price (£ per ton-mile)	0.0065	0.0065	0.0065
c) Railway freight revenues (million £) (a x b)	2.335	2.335	2.335
2. Counterfactual economy			
d) Carting transport freight (million ton-miles)	361.03	361.03	361.03
e) Carting transport price (£ per ton-mile)	0.0204	0.0305	0.0153
f) Carting transport cost (million £) (d x e)	7.377	11.003	5.520
Social savings (million £) (f –c)	*5.042*	*8.668*	*3.185*
As % of GDP	*12.01*	*20.64*	*7.58*

Table A.2. Passenger transport (all classes)

	Original estimate	Time savings = 0% of travel time	Time savings = 100% of travel time	wages 50% higher	wages 50% lower	Stagecoach price 50% higher	Stagecoach price 50% lower
a) Railway output (million passenger-miles)	**324.480**	324.480	324.480	324.480	324.480	324.480	324.480
b) Railway output (million £)	**1.210**	1.210	1.210	1.210	1.210	1.210	1.210
c) Working travel time by rail (million hours)	**9.471**	0	18.942	9.471	9.471	9.471	9.471
d) Value of working travel time by rail (million £)	**0.267**	0	0.533	0.400	0.133	0.267	0.267
e) Counterfactual road transport output (million passenger-miles)	**324.480**	324.480	324.480	324.480	324.480	324.480	324.480
f) Counterfactual road transport output (million £)	**2.043**	2.043	2.043	2.043	2.043	3.065	1.022
g) Working travel time by road transport (million hours)	**68.482**	0	136.696	68.482	68.482	68.482	68.482
h) Value of working travel time by road transport (million £)	**1.622**	0	3.243	2.433	0.811	1.622	1.622
i) Saving on transport costs (million £) (*f* – *b*)	**0.833**	0.833	0.833	0.833	0.833	1.854	-0.189
j) Saving on travel time (million £) (*h* – *d*)	**1.355**	0	2.710	2.033	0.678	1.355	1.355
k) Total savings (million £) (i + j)	***2.188***	*0.833*	*3.543*	*2.866*	*1.511*	*3.210*	*1.167*
l) As % of GDP	***5.21***	*1.98*	*8.44*	*6.82*	*3.60*	*7.64*	*2.78*